1

NETWORKING WITH MICROSOFT WINDOWS 2000 SERVER

After reading this chapter and completing the exercises you will be able to:

♦ Plan what network model to apply to your network

♦ Compare the differences between Windows 2000 Professional, Server, Advanced Server, and Datacenter

♦ Explain Windows 2000 capabilities as a server operating system

♦ Explain the new features in Windows 2000

♦ Describe the file systems that are compatible with Windows 2000 and choose the file system that is right for your server

Microsoft Windows servers reach millions of people each day in mundane and dramatic ways. When you use the Internet to check stock quotes, pur–chase a music CD, or access your favorite news Web site to play local or national news clips, chances are that you are linking into a Microsoft Windows NT or Windows 2000 server. On–call physicians are paged for emergencies, organ donors are located, and new medical procedures are taught through the help of Microsoft Windows servers. The next time you apply for a job, send an e-mail, develop a budget, or take a class, the facilitator in the background may be a Microsoft Windows server. The audio, video, or game entertainment on your next airline flight may be brought to you by a Microsoft Windows server, and you may arrange where to stay at your destination through the same server.

All of these technologies exist now, and new ones are available nearly every day. As a new or experienced Microsoft Windows 2000 Server professional, you have a ground-floor opportunity to participate in a technology that is pushing the boundaries of information sharing. This chapter introduces you to peer-to-peer and server-based networking, and to the new features and capabilities of Windows 2000. You also learn about the role of Microsoft file systems and how to plan which file system to implement.

PLANNING A NETWORKING MODEL

Microsoft Windows 2000 Server is a server **network operating system** (**NOS**). It is used to coordinate the ways our computers access resources available to them on the network. A **network** is a communications system enabling computer users to share computer equipment, application software, and data, voice, and video transmissions. Physically, a network contains computers joined by communications cable or sometimes by wireless devices. Networks can link users who are in the same office or building, in a different state, or as far away as on a different continent (see Figure 1-1).

Network in the United States

Network in Australia
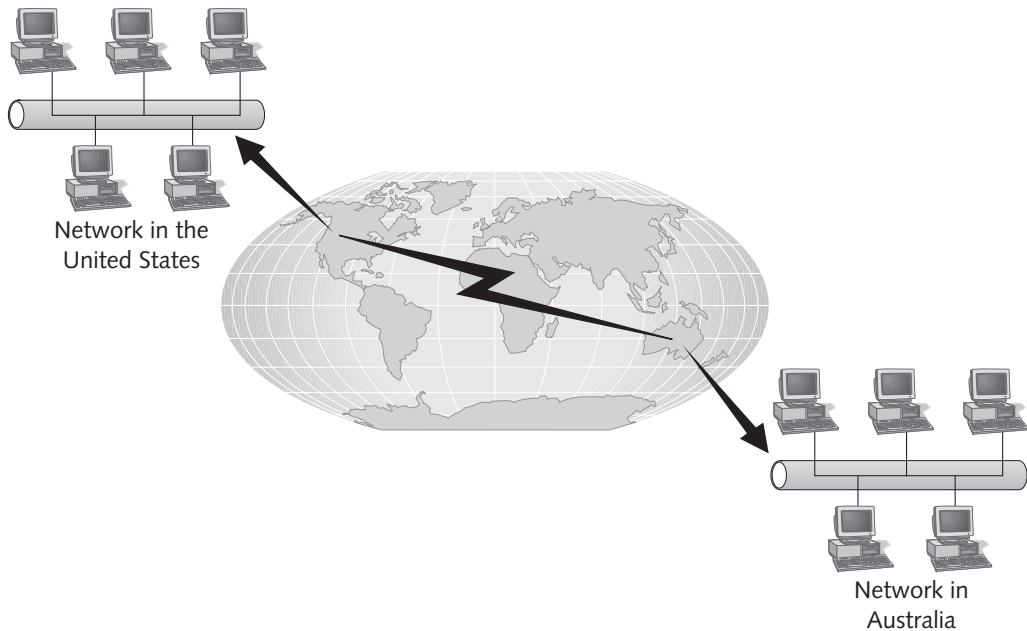
Figure 1-1   Networking across continents

A workstation or client NOS is one that enables individual computers to access a network, and in some cases to share resources on a limited basis. A **workstation** is a computer that has its own central processing unit (CPU) and may be used as a standalone or network computer for word processing, spreadsheet creation, or other software applications. A **client** is a computer that accesses resources on another computer through a network or by a direct connection.

Microsoft Windows 2000 Server can be implemented using either of two models for networking, or a combination of both: peer-to-peer networking and server-based networking. **Peer-to-peer networking** focuses on spreading network resource administration among server and nonserver members of a network, while **server-based networking** locates administration on one or more servers. Often small organizations use the peer-to-peer networking model, while middle-sized and large networks use the server-based model—although Windows 2000 Server enables flexibility in using either model.

Using Peer-to-Peer Networking

A peer-to-peer network is one of the simplest ways to network. On a peer-to-peer network, workstations communicate with one another through their own operating systems. Windows 98 is an example of an operating system that can be used for peer-to-peer network communication. Files, folders, printers, and the contents of entire disk drives can be made available on one computer for others to access. No special computer, such as a mainframe computer or server, is needed to enable workstations to communicate and share resources (see Figure 1-2).
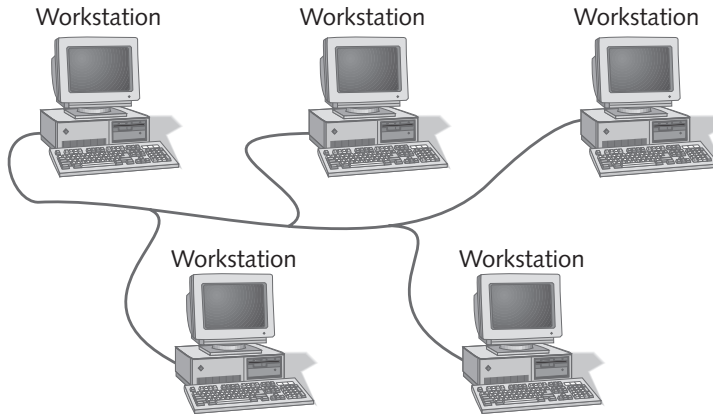
Figure 1-2   A simple peer-to-peer network without a server

> **TIP**   Although a server can be used as a powerful workstation in a peer-to-peer context, generally this is not an effective use of its management capabilities.

Using Windows 98 alone, a group of computer users can set up workgroups to help them share information and work as a team. A **workgroup** is a grouping of computer users who share one or more resources, for example files and printers, in a decentralized way. Consider a small tax accounting firm that employs seven people, each with her or his own computer that is connected to a simple network. The most recent tax rules can be placed in a folder on one computer that is shared with all others. Blank electronic tax forms can be placed in a folder on another computer, and a third computer might house a database of customer information. In this case, spreading the information among the three computers enables it to be housed with the workgroup member who is responsible for maintaining it. Also, the firm can save money by purchasing only one or two printers to share on the network, instead of purchasing one for each computer.

Strict peer-to-peer networking can be effective for very small networks, but there are problems when resource management is totally decentralized. In our accounting office example, if workgroup members turn off their computers, no one can access their shared resources. Another problem is that a workstation operating system is not designed to handle a growing load of clients in the same way as a server operating system.

As a general rule, when a workgroup grows to over 10 members, peer-to-peer networking is much less effective for several reasons:

- It offers only moderate network security. Access to information can be limited to a certain drive or folder, but not to individual files. Also, access to financial data cannot be audited.

- There is no centralized storage or account management. As the number of network users grows, so does the need to have a central place to store and manage information. It is much easier to manage files by locating them on a central file server for all to access.

- Network management becomes more difficult because there is no point of centralized administrative control from which to manage users and critical files, including backing up important files.

- Peer-to-peer networks can soon experience slow response because this model is not optimized for heavy multiple access to one computer. If many workgroup members decide to access one shared drive or other shared resources at the same time, all are likely to experience slow computer response from the load.

Using Server-based Networking

Microsoft Windows 2000 Server is a more robust network operating system than Windows 98 or Windows 95. Like Windows 98 and Windows 95, you can run programs on Windows 2000 Server and use desktop features such as My Computer to view folders and the Start button to launch programs (try Hands-on Projects 1-1 and 1-2.) But Windows 2000 Server offers much more because it is a multipurpose server that enables full-scale network resource management. A **server** is a single computer that provides extensive multiuser access to network resources. For example, a single Windows 2000 Server can act as a file and print server, a Web server, a network administration server, a database server, an e-mail server, or a combination of any of these. Depending on the hardware capabilities, the server is designed to handle hundreds of users at once, resulting in faster response when delivering the shared resource, and less network congestion as multiple workstations access that resource. Figure 1-3 illustrates a network with a file server (try Hands-on Project 1-3 to view computers on a network).

The server-based model offers a wide array of options for modern networking. For instance, implementing Windows 2000 Server can provide the following advantages:

- All members can share computer files.

- Printers and other resources can be shared; they can also be located in a central place for convenience.

- Access to resources can be centrally controlled and administered.

- All members can have electronic mail (e-mail) and send messages to other office members through the network and file server.

- Members can share software applications, such as an accounting package or word processing software. This provides an opportunity to have everyone using the same software (and the benefits of common support for one software package).
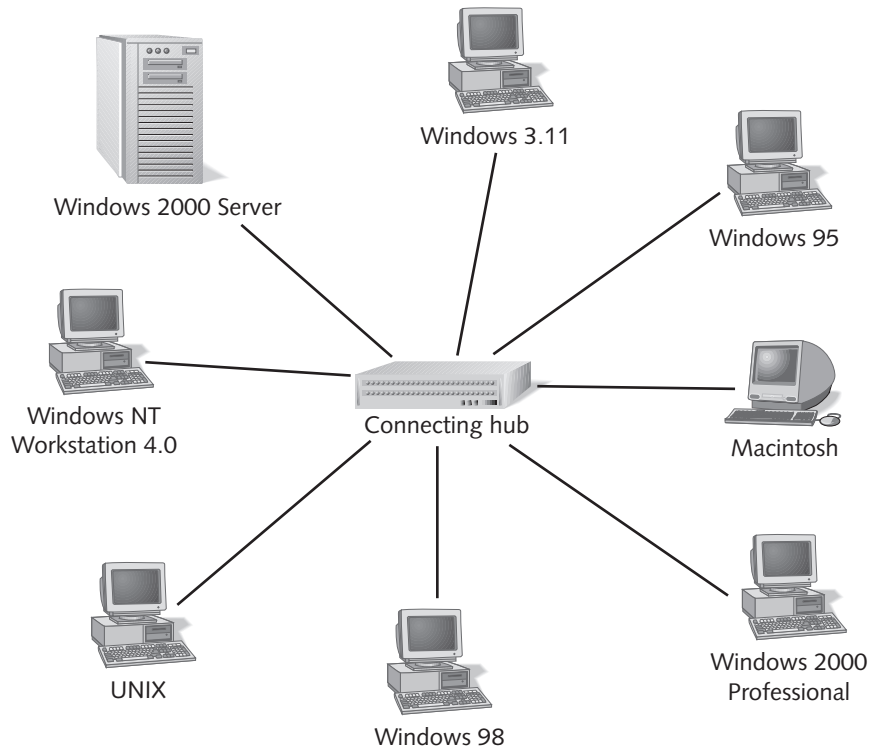
Figure 1-3   A server-based network

- All computers can be backed up more easily. With a network and file server, the backups can be done from one location and regularly scheduled to run from the server. The server can be backed up, too.

- The sharing of computer resources can be arranged to reflect the work patterns of groups within an organization. For example, managing partners in a firm can be one group for the purpose of sharing management and financial information on the server.

- The server administrator can save time when installing software upgrades. For example, to implement the latest version of Microsoft Word, the administrator will upgrade only the software at the server. Microsoft Word users on the network can upgrade their versions from the server.

WINDOWS 2000 SERVER AND WINDOWS 2000 PROFESSIONAL COMPARED

Microsoft offers versions of Windows 2000 designed for server and workstation implementations. The basic server version is called Windows 2000 Server, and Windows 2000 Professional is designed for workstations. Microsoft's overall goal is to combine Windows 2000 Server and Windows 2000 Professional on a server-based network to achieve a lower **total cost of**

ownership (**TCO**). The TCO is the total cost of owning a network, including hardware, software, training, maintenance, and user support costs. Windows 2000 Professional is intended as a reliable, easy-to-configure workstation operating system to be used in a business or professional environment. Also, recognizing that professionals are highly mobile, Windows 2000 Professional is designed to work equally well on a desktop computer or a laptop. Windows 2000 Server is intended to play a key management role on the network by administering the **Active Directory**—a database of computers, users, groups, shared printers, shared folders, and other network resources—and a multitude of network services. Also, by combining Windows 2000 Professional workstations and Windows 2000 Server on the same network, it is possible to centralize software updates and workstation configuration via a server.

Microsoft's long-term objective is to encourage users to convert all workstation operating systems on a network to Windows 2000 Professional, because the TCO for Windows 2000 Professional is less than for other workstation NOSs such as Windows 95 and Windows 98. The TCO is less because Windows 2000 Professional is able to use automated configuration and software features designed for it in Windows 2000 Server. Network connectivity, desktop setup, and fast installation of standardized software can be automated from Windows 2000 Server to Windows 2000 Professional, so that the user can set up a workstation with practically no technical knowledge or assistance.

> A study conducted by International Data Corporation and reported by Kathleen Ohlson in *Network World* ("Managed Environments Lower Costs, Analysts Say," February 2, 1998) shows that the yearly TCO of a workstation on an average network is $10,400. This cost can be reduced by two-thirds or more when centralized server services are used to reduce configuration, support, and maintenance costs.

Windows 2000 Professional and Windows 2000 Server share the same hardware memory capability to support up to 4 GB of RAM. Both also share the same new interface and desktop features. Beyond these similarities, Windows 2000 Server supports up to four processors, while Windows Professional supports up to two. Windows 2000 Server also offers more services and user connectivity options that are appropriate for a server instead of a workstation. These services include the following:

- The capability of handling virtually unlimited numbers of users simultaneously (depending on the hardware platform). Windows 2000 Professional is designed optimally for 10 simultaneous users
- Active Directory management
- Network management
- Web-based management services
- Network-wide security management
- Network storage management
- Remote network access, network-wide communications services, and high-speed network connectivity
- Application services management
- Network printer management through the Active Directory

WINDOWS 2000 SERVER, ADVANCED SERVER, AND DATACENTER COMPARED

Windows 2000 Server is divided into three different products to match the network application: Windows 2000 Server, Windows 2000 Advanced Server, and Windows 2000 Datacenter. Windows 2000 Server provides a comprehensive set of server and Web services for up to four-processor systems and supports up to 4 GB of RAM. Windows 2000 Advanced Server is intended for high-end enterprise networks that require up to eight-processor servers, clustered servers, or both. **Clustering** is a technique in which two or more servers are linked to equally share the server processor load, server storage, and other server resources (see Figure 1-4). Windows 2000 Advanced Server also has the ability to handle up to 8 GB of RAM. Windows 2000 Datacenter is targeted for large database and data manipulation services. The Datacenter version supports 64 GB of RAM, clustering, and individual servers with up to 32 processors.
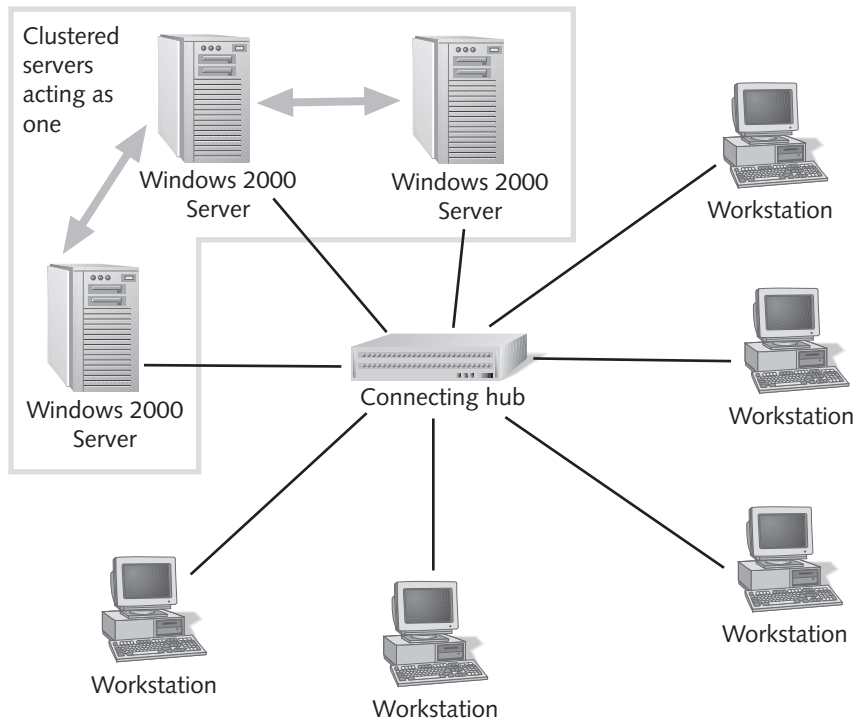

Figure 1-4   Server clustering

WINDOWS 2000 SERVER CAPABILITIES

Like its Windows NT Server predecessor, Microsoft Windows 2000 Server is equipped with a range of capabilities that makes it a versatile server NOS. These capabilities make it at home

as a file server, a Web server, or a center for client/server applications. The Windows 2000 Server capabilities include the following:

- Sharing resources
- Managing resources
- Security
- Scalability and compatibility
- Reliability
- Distributability
- Fault tolerance
- Internet integration and electronic commerce

> Windows 2000 Server has been in development since 1994 and contains about 45 million lines of computer code, compared to Windows NT Server 4.0, which has about 15 million lines of code.

Sharing Resources

Data files, software, and print services are examples of resources that a file server can make available on a network. Before file servers, PC users carried files on disk from office to office (a method sometimes called the "sneakernet"). At one university, a budget officer created disks of budget information, which were then distributed to each department. Every department would review the disk files, make changes, and send its disk back to the budget officer to be incorporated in the calculations for the next budget. Creating a university-wide budget involved lots of work since over a hundred disks were carried back and forth to distribute original data, and make corrections or additions.
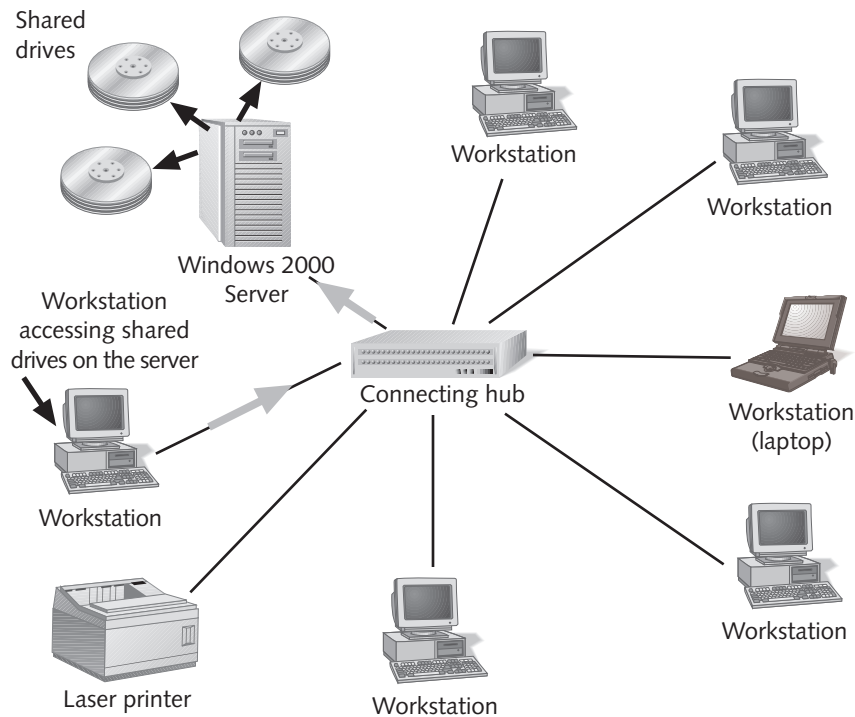
The implementation of a network and a server changed the effort to create a new budget each year. With a network, the budget officer could put data files on the server. Each department could access its own budget information, share it with others in the department, adjust the data, and return it, all without asking anyone to leave his or her office.

A Windows 2000 file server enables files that need to be used by several people to be stored at one location for all to access. Those who have accounts or authorized access to the file server can quickly obtain shared files. By storing information in one place, controls can be set up to ensure everyone obtains the same, consistent, data. It is easier to back up data, too, because of its central location.

Windows 2000 servers provide options to share files by creating a shared folder. When a shared folder is available through the network, a user with the right authorization can map that folder as though it were a drive on his or her computer (see Figure 1-5). A **mapped folder** or **drive** is shared on the network by a file server or workstation. It gives designated network workstations access to the files and data in its shared volume or folder. The

workstation, via software, determines a drive letter for the shared volume, which is the workstation's map to the data (try Hands-on Project 1-10).

Shared
drives

Windows 2000
Server

Workstation
accessing shared
drives on the server

Workstation

Laser printer

Connecting hub

Workstation

Workstation

Workstation

Workstation
(laptop)

Workstation

Workstation

Figure 1-5 Accessing shared server drives

Windows 2000 Server print services enable many kinds of printers to be shared on a net-work. For example, a printer connected to the server can be shared with all network users or only with a designated group of users. Print services to other shared network printers also can be managed from the server.

Many offices find network print services save on making a substantial investment in printing equipment. For example, in an office with six people working in close proximity, all can share a single network printer instead of purchasing six printers, one for each employee. In another example, an architectural firm can save by sharing one expensive plotter for printing building drawings, instead of purchasing lower-quality plotters for each architect.

Another advantage of Windows 2000 Server is the ability to load or run software applications on workstations across the network. A site license can be purchased to have one shared copy of a word processor or one shared copy of an entire suite of programs, such as Microsoft Office, installed on the server. For example, if the site license is for 400 users, then that many users have the option to install it from the file server to their workstations over the network. Another option is to run a network version of the software, which means that only a few utility files are permanently loaded at the workstations, while the main program files are always loaded from the server each time the program is started. The advantage of this method is that

it saves workstation disk space. A disadvantage is that it may create an excessive load on the server and the network, if there are several hundred users who have network installations.

Using application services on a network can save the network administrator or client support people hours of work. When a software upgrade is released, the network administrator loads one copy on the server that can be shared by all users. This represents hours of savings when compared to purchasing individual licenses and loading the software at each workstation, such as in our example of 400 users. Also, by using the file server as the central application program source, it is easier to ensure that all users have the same software and version level. This saves many hours for client support people by reducing the need to support an extensive range of software and different software versions.

Managing Resources

A server-based network consists of **resources** that can be managed through Windows 2000 Server. Windows 2000 Server offers a way to centralize management of network resources in order to simplify network management tasks. The network resources are file servers, workstations, shared printers, and shared folders. With Windows 2000 Server, the network administrator can manage access to software, the Internet, print services, data files, and other network services.

One way in which a Windows 2000 server helps manage a network is through the Active Directory and container objects such as domains, organizational units, trees, forests, and sites. These objects are explained in Chapter 4. They offer a way to manage resources, workstations, software, and the network from one central location. For the network administrator, they offer a way to manage the network resources with minimum confusion and time expenditure.

Security

At one time computer security was given little attention. Today, security is an important issue. File servers house sensitive data that must be protected from intruders accessing it through a local network or via the Internet. Windows 2000 Server is compatible with a C2 top-secret security rating from the United States government. The C2 rating means that a server NOS provides security at many levels through the following:

- File and folder protection
- Account and network access passwords
- File, folder, and account auditing
- Server access protection on a network
- Server management controls

Scalability and Compatibility

Most users want a system that can grow as their organization's needs grow. **Scalability** is the ability of a computer operating system to function on a range of computers from small to large. For example, you might start out with a single-processor Pentium server and 100 users. In a year,

you grow to 400 users and find you need a more powerful server, such as a four-processor computer. When you move from the single-processor to the four-processor computer, you want to also move the operating system, in order to keep your investment in software.

Windows 2000 Server can be scaled to handle substantial growth. The operating system can support from 1 to 15,000 user connections. It works on both single-processor and multi-processor computers, including 80486s, Pentiums, and **symmetric multiprocessor** (**SMP**) computers. Windows 2000 Server (Datacenter) can run on computers that have up to 32 processors, depending on the capability of the hardware, and it runs on thousands of different computers.

Windows 2000 Server also can handle small and large databases. Microsoft Access is an example of a small database system that works with Windows 2000 Server. Larger database capabilities are fulfilled by relational database systems such as Microsoft SQL Server and Oracle. A single database on a Windows 2000 server can hold more than 200 GB of information and have more than 5,000 users accessing it at the same time.

Another area of advancement is the ability to communicate with a wider range of computers and networks. Windows 2000 Server communicates with IBM, Novell, UNIX, Banyan, DEC, and other network operating systems. Also, it can be accessed by workstations with any of the following operating systems (try Hands-on Project 1-4):

- MS-DOS
- Windows 3.x
- Windows 95 and Windows 98
- Windows NT and Windows 2000
- Macintosh
- UNIX

Reliability

Several features of Windows 2000 Server make it reliable and powerful. One feature is that the Windows 2000 Server operating system kernel runs in privileged mode, which protects it from problems created by a malfunctioning program or process. The **kernel** consists of the core programs and computer code of the operating system. The **privileged mode** gives the operating system kernel an extra level of security from intruders and prevents system crashes due to out-of-control applications.

When a user runs an MS-DOS program on Windows 2000 Server, the operating system uses the **virtual DOS machine** component. The virtual DOS machine tricks the MS-DOS application into responding as though it were the only application running. Each virtual DOS machine session runs in a separate memory space, and several MS-DOS programs can be running at once, each within a different virtual DOS machine session. If a program attempts to make a direct call to memory or to a hardware component, and the operating

system detects an error condition or an exception to security, the program may be stopped by Windows 2000.

> **Note**
> The virtual DOS machine consists of two processes, which are Ntvdm.exe and Wow.exe ("Wow" stands for Windows on Windows). It also employs two system files that consist of virtual device drivers, Ntio.sys and Ntdos.sys.

Windows 2000 Server also runs 16-bit Windows applications by using the virtual DOS machine. When the 16-bit program is started, Windows 2000 starts a virtual DOS machine session and then starts a 16-bit version of Windows within that session (try Hands-on Project 1-7). If an error occurs when you run a 16-bit Windows program, Windows 2000 Server can terminate the program without affecting another program or process that is active.

Another powerful feature of Windows 2000 is that it takes full advantage of the multitasking and multithreading capabilities of modern Pentium computers. **Multitasking** is the ability to run two or more programs at the same time. For example, Microsoft Word prints a document at the same time that a Microsoft Excel spreadsheet is calculating the sum of a column of numbers. **Multithreading** is the capability of programs written in 32-bit code to run several program code blocks, or "threads," at the same time. For instance, a Microsoft Access database query runs a thread to pull data out of the database, while another thread generates a subtotal of data already obtained.

The multitasking in Windows 2000 is called preemptive multitasking. That means each program runs in an area of memory separate from areas used by other programs. Early versions of Windows used cooperative multitasking, in which programs shared the same memory area. The advantage of preemptive multitasking is that it reduces the risk of one program interfering with the smooth running of another program.

Distributability

There are many software applications written to distribute functions among computers. For example, a sales analysis program might use programs at one computer, databases from two other computers, and special information display screens at a user's computer. The process of dividing computer functions across many computers is called **distributability**.

Windows 2000 Server handles software distributability through the **Distributed Component Object Model** (**DCOM**), a capability designed for client/server networks so that software applications can be integrated across several computers. For example, DCOM makes it possible to integrate a payroll system for a company with multiple locations, housing Windows 2000 servers and workstations at each location. The payroll applications and database information can be maintained at and coordinated among all locations.

Fault Tolerance

Computer software and hardware sometimes fail for many reasons. Protection from these failures is called **fault tolerance**. Windows 2000 Server comes with many fault-tolerance capabilities. Some of those fault-tolerance options are as follows:

- Recovery from hard disk failures
- Recovery from lost data in a file
- Recovery from system configuration errors
- Protection from power outages
- Advanced warning about system and hardware problems (try Hands-on Project 1-5)

Internet Integration and Electronic Commerce

Many organizations are interested in offering information or services on the **World Wide Web** (**Web** or **WWW**) through the Internet. Windows 2000 Server is designed as a home for Microsoft's Web server software called Internet Information Services (IIS). IIS gives organizations the ability to take advantage of intranet software as well as Internet software. The **Internet** is a collection of thousands of smaller networks tied together around the globe by a vast array of network equipment and communications links; an **intranet** is a private network within an organization. Like the Internet, an intranet uses Web-based software and the TCP/IP communications protocols, but intranets are highly restricted from public access. Intranets are currently used to enable managers to run high-level reports, to enable staff members to update human resources information, and to provide access to other forms of private data.

Windows 2000 Server has a service, called the Indexing Service, that automatically indexes the content of information created for Internet and intranet access within a company. Index information is created for **Hypertext Markup Language** (**HTML**), text files, or Microsoft Office documents, such as Microsoft Word. The Indexing Service enables quick searches for the indexed topics, while using low network overhead.

Microsoft has a strong commitment to Web development. It offers the IIS for Windows NT Server and Windows 2000 Server, and Peer Web Services for Windows 2000 Professional, Windows NT Workstation, Windows 98, and Windows 95. Microsoft also offers FrontPage for Web development, and HTML-formatting options are built into Microsoft Office.

NEW FEATURES INTRODUCED IN WINDOWS 2000 SERVER

Windows 2000 Server incorporates a wide range of new features that are designed to make it more flexible for existing and future network technologies. The new features that are of particular interest to network and server administrators include:

- *Active Directory*: The Active Directory is a database that is used to store information about resources such as user accounts, computers, and printers; it groups resources at different levels (hierarchies) for local and universal management.

These groupings are called containers, because they are like storage bins that can hold network resources and other lower level bins. The Active Directory also provides a centralized means to quickly find a specific resource through indexing.

The Active Directory is an example of a directory service, similar to Novell Directory Service (NDS), which is a design concept that enables network resources to be centralized for easier management. A directory service is often compared to a telephone book because it provides a way to easily find one or more resources, including specific attributes of those resources. In a directory service, each object has associated attributes that are appropriate to that object. The attributes of a user account, for instance, include the account name, the user's full name, the resources that the user shares on the network, security restrictions, and groups to which the user belongs. Significantly, a directory service goes beyond a telephone book in that it provides a way to manage resources.

- *Distributed network architecture (DNA)*: Windows 2000 Server offers new ways to distribute network and management resources, to match the needs of all types of networks. One important change from Windows NT Server 4.0 is that there is no longer one server, called the primary domain controller, that maintains the master copy of account and security information plus one or more servers, called backup domain controllers, that keep copies of this information as a backup. In Windows 2000 Server, multiple servers can be designated as domain controllers, each containing a copy of the Active Directory and able to verify a user who wants to log onto the network. Windows 2000 Server supports the Distributed File System (Dfs), which enables users to employ the Active Directory and Windows Explorer to consolidate files, folders, and resources from various servers and computers into a single tree structure for easier access.

- *Kerberos security*: **Kerberos** is a security system that enables two parties on an open network to communicate without interception from an intruder. Kerberos works through a special communications protocol that enables a client to initiate contact with a server and request secure communication. The server responds by providing an encryption key that is unique to that communication session, and it does so by using a protected communication called a ticket.

- *Flexible server and network management*: One of the most flexible and powerful management tools, offering a huge range of capabilities, is the Microsoft Management Console (MMC). The MMC is a management tool that you customize by choosing among "snap-in" modules, which can be installed or removed at will. One advantage of this approach is that all management functions can be accessed from one place, instead of having to be accessed from several places, as in Windows NT 4.0 (try Hands-on Project 1-6 to view the MMC snap-ins).

- *IntelliMirror*: IntelliMirror is a concept built into the combined use of Windows 2000 Server and Windows 2000 Professional. It is intended to enable Windows 2000 Professional clients to access the same desktop settings, applications, and data regardless of the location from which they access the network or even if they are not on the network. IntelliMirror also uses information in the

Active Directory to ensure that consistent security and group policies apply to the client and that the client's software is upgraded or removed on the basis of a central management scheme.

- *Web-based Enterprise Management (WBEM)*: Web-based Enterprise Management is intended as a means to make life easier for network and server administrators. WBEM is an attempt to standardize the tools and interfaces used by administrators to gain a total picture of the relationship between their networks and the physical devices connected to their networks, servers, and workstations. WBEM uses the Common Information Model (CIM), which is a proposed standard, to obtain consistent tracking and management information about a network and its attached devices.

- *Hierarchical Storage Management (HSM)*: Through **Hierarchical Storage Management** (**HSM**), information is stored on the basis of policies set up by the server administrator, so that users can access all kinds of information no matter where it is stored, and that the information is stored economically. It is expensive and unnecessary to attempt to store all information on hard disks, when less expensive removable media such as Zip disks, tapes, CD/ROMs, and read/write CD-ROMs are available. HSM enables the administrator to decide which medium is most appropriate for information storage.

- *Zero Administration for Windows (ZAW)*: **Zero Administration for Windows** (**ZAW**) is a combination of management techniques and tools that enable an organization to reduce TCO. Most of the new features already described for Windows 2000 Server are part of ZAW—Active Directory, distributed network architecture, improved security, expanded management capabilities, IntelliMirror, WBEM, and HSM.

- *Power management*: Power management is handled through OnNow, which is similar to power management in Windows 95 and Windows 98, enabling portions of a system, such as hard disks and the monitor, to "sleep" when they are not in use for a specific period of time.

- *International language compatibility*: Windows 2000 supports more languages and language capabilities than previous versions of Windows, including Hindi, Chinese, and multiple versions of English. This is an important feature, because servers are used all over the world.

FILE SYSTEM COMPATIBILITY

Windows 2000 Server primarily supports two file systems: the File Allocation Table (FAT) file system and NT File System (NTFS). It also supports conversion of the OS/2 High-Performance File System (HPFS) to NTFS.

FAT

The **File Allocation Table** (**FAT**) **file system** is an older file system that was initially designed for computers with small disk systems, such as early computers with 20, 40, 100,

250, or 500 MB of disk storage. Most computers sold today come with much larger disk storage, such as 4, 8, or 10 GB, or more. Because today's applications and data files quickly consume disk space, many computer owners are purchasing additional disk drives.

FAT was developed to use with MS-DOS and is compatible with Windows NT and Windows 2000, Windows 95, Windows 98, OS/2, and various UNIX computer operating systems. The early version of FAT has become known as FAT16, because it was designed for 16-bit systems. FAT32 is a later version of FAT that was introduced in Windows 95 operating system release 2 (Windows 95 OSR2).

FAT16 disk drives are set up in a series of allocation units (previously called clusters) to form a partition. An allocation unit may consist of 2, 4, or 8 sectors on a disk. Files are created from one or more allocation units. The operating system keeps track of used and unused allocation units in a disk area called the file allocation table, which is kept in the beginning allocation units of the partition. The file allocation table has one of four types of entries for each allocation unit, indicating:

- That the unit is available to be used
- A number showing the next allocation unit occupied by a file
- An end-of-file mark showing the last allocation unit for a file using several allocation units
- A mark indicating that the allocation unit is damaged or cannot be read

A FAT system also contains lists of associated files that form a directory. A directory tracks the following information or attributes about its files:

- Name
- Time and date of creation or last update
- Attributes, such as read-only
- Size
- Number of the first allocation unit it occupies

FAT16 has several advantages:

- It is a simple file system that is supported by many small computer operating systems.
- It has a low operating system overhead.
- It can support partitions up to 4 GB.
- It can support file sizes up to 2 GB.

Some important disadvantages of FAT16 are:

- It becomes corrupted over time as files are spread among disjointed allocation units and pointers to each unit are lost.
- FAT does not offer many file or directory security or auditing options.
- It does not support long filenames; filenames are limited to 11 characters, 8 for the main name and 3 for an extension.

The FAT32 system is supported only by Windows 95 OSR2, Windows 98, and Windows 2000. In Windows 95 and Windows 98, it enables smaller allocation units than FAT16 and can support partitions of from 2 GB to 2 TB (terabytes). In Windows 2000 it also allows smaller allocation units than FAT16, but the largest FAT32 partition is limited to 32 GB or smaller. In all three operating systems, the largest FAT32 file size is 4 GB. FAT32 does include support for long filenames.

NTFS

The **NT File System** (**NTFS**) is the native Windows NT and Windows 2000 file system, a modern system designed for the needs of a network server environment. Windows NT 4.0 uses NTFS version 4 (NTFS 4) and Windows 2000 uses NTFS 5. The Windows NT Service Pack 4 update for Windows NT 4.0 provides an add-on that enables that operating system to access partitions that are formatted for NTFS 5.

As a full-featured network file system, NTFS is equipped with security features designed to meet the U.S. government's C2 security specifications. C2 security refers to high-level "top-secret" standards for data protection, system auditing, and system access, which are required by some government agencies. NTFS also incorporates such features as:

- Long filenames
- File compression
- Large file capacity
- File activity tracking
- POSIX support
- Volume striping and volume extensions

NTFS enables the use of filenames of up to 256 characters. This is an advantage over the FAT16 system, because files can more easily be named to reflect their contents.

NTFS security accomplishes several goals. One is to create security measures to determine what type of access is allowed for users of folders and of files within folders. The file and folder access can be tailored to the particular requirements of an organization. For example, the system files on a server can be protected so that only the server administrator has access. A folder of databases can be protected with read access, but no access to change data; and a public folder can give users in a designated group access to read and update files, but not to delete files.

File compression is a process that significantly reduces the size of a file by techniques such as removing unused space within a file or using compression algorithms. Some files can be compressed by more than 40 percent, saving important disk space for other storage needs. This is particularly useful for files that are accessed infrequently. NTFS provides the ability to compress files as needed.

File compression can be used on specified files after the server is generated (explore this capability via Hands-on Project 1–8). A disadvantage is that compressed files take longer to access, because they must be decompressed when retrieved.

NTFS can be scaled to accommodate very large files, particularly for database applications. A Microsoft SQL Server database file might be 20 GB or larger. This means an organization can store pictures, scanned images, and sound clips in a single database. The NTFS system can support files up to 16 exabytes (in theory).

Another NTFS feature is that it keeps a log or journal of file system activity. This is a critical process should there be a power outage or hard disk failure. Important information can be retrieved and restored in these situations. FAT does not have this capability.

NTFS provides support for the **portable operating system interface** (**POSIX**). POSIX is a set of standards designed to enable portability of applications from one computer system to another and has been used particularly for UNIX systems. Windows 2000 follows the POSIX 1 standard, which includes case-sensitive filenames and the use of multiple filenames (called hard links). For example, the files Myfile.doc and MYFile.doc are considered different files (except when using Explorer or the Command Prompt window).

Two important volume-handling features of NTFS are the ability to create extensions on an existing volume (such as when new disk storage is added) and the ability to stripe volumes, which is a process that equally divides the contents of each file across two or more volumes as a way to extend disk life, enable fault-tolerance features, and balance the disk load for better performance.

In addition to the NTFS 4 features already described, NTFS 5 adds several new features:

- Ability to encrypt files
- No system reboot after creating an extended or spanned volume
- Ability to reduce drive designations
- Indexing for fast access
- Ability to retain shortcuts and other file information when files and folders are placed on other volumes
- Ability to establish disk quotas

With NTFS 5, files can be encrypted so that their contents are available only to those granted access. Also, volume extensions can be set up without the need to reboot the system (in NTFS 4 you have to reboot after adding an extension onto an existing volume). Volume mount points can be created as a way to reduce the number of drive designations for multiple volumes, instead of designating a new drive per each new volume. NTFS 5 incorporates fast indexing in conjunction with the Active Directory to make file searching and retrieval faster than in NTFS 4. A new technique called Distributed Link Tracking is available in NTFS 5, so that shortcuts you have created are not lost when you move files to another volume. Finally, NTFS 5 enables you to set up disk quotas to control how much disk

space users can occupy. Disk quotas are a vital tool for disk capacity planning and to ensure that there is enough disk space for all server operations and critical files.

> **TIP** NTFS 4 does not have built-in disk quota capabilities, but third-party software is available to set up disk quotas.

A limitation of NTFS is that it is designed for Windows NT and Windows 2000 systems. For example, if you set up a computer to run both Windows 2000 and Windows 98 (called a dual-boot system), Windows 98 will not recognize the NTFS files when it is running. (Try Hands-on Project 1-9 to view the properties of an NTFS folder.)

> **TIP** Third-party utilities are available to enable Windows 95 and Windows 98 to view NTFS-formatted files on a dual-boot computer.

CDFS and UDF

Windows 2000 recognizes two additional file systems used by peripheral storage technologies. The **compact disc file system** (**CDFS**) is supported so that Windows 2000 can read and write files to **compact disc** (**CD-ROM**) disk drives. CD-ROM capability is important for loading the Windows 2000 operating system and for sharing CD-ROM drives on a network. The **Universal Disk Format** (**UDF**) file system is also used on CD-ROM and large-capacity **digital video disc** (**DVD-ROM**) media, which are used for huge file storage to accommodate movies and games.

Choosing a File System

If Windows 2000 Server is intended for a computer with only one disk drive that has less than 2 GB of disk storage, then the FAT file system may be sufficient. It can also be used when the disk is under 2 GB and you have MS-DOS, Windows 3.1x, or Windows 95 OSR1 also loaded on the same computer, using FAT16 (a dual-boot system). Also, you may need to use FAT32 for a dual-boot system in which Windows 95 OSR2 or Windows 98 accompany Windows 2000 on the same computer and you are using a 2 GB or larger disk.

On most modern Windows 2000 servers, NTFS is preferred over FAT16 or FAT 32 because it has so many more capabilities that you need for a network, particularly for security. Also, most servers have the type of users who need a system that can handle demanding applications with high memory and disk requirements. Particularly for systems with 2 GB or more of disk storage or more than one hard drive, NTFS is the best choice. NTFS is better at handling file operations on large disks and can combine multiple drives so that they are recognized under one drive letter, such as one logical drive C. Also, for users who anticipate extremely large disk requirements, NTFS supports a much larger total volume size.

Security is another important consideration in the selection of a file system on a server. FAT has limited security capabilities, such as setting an attribute to make a file read–only or hidden. NTFS has extensive security based on permissions. Permissions are a security property that can be placed on a drive, folder, or file. For example, access to a folder can be restricted to a certain group of users so that any group member has authority to read a file and add new files to the folder. Non–group members can be prevented from accessing the folder entirely. Also, the NTFS system enables a folder or file to be audited, so there is a record of the number of times that a file is successfully opened.

Another advantage of NTFS, which many administrators prefer, is transaction logging. If a disk error occurs while a file is being updated, the data is recovered in an instant. FAT uses file caching, which also enables it to recover data after a disk problem. But the FAT recovery may not be as quick or as accurate if there have been many updates recorded in cache.

A disadvantage of using NTFS is that the server contents cannot be converted back to FAT16 or FAT32, should there be a need. However, a FAT16 or FAT32 partition can be converted to NTFS on a one–time basis. Table 1–1 compares the FAT16, FAT32, and NTFS file systems.

Table 1-1   FAT and NTFS compared

Feature	FAT16	FAT32	NTFS
Total volume size	4 GB	2 GB to 2 TB	2 TB
Maximum file size	2 GB	4 GB	Theoretical limit of 16 exabytes
Compatible with floppy disks	Yes	Yes	No
Filename length	11 characters	256 characters	256 characters
Security	Limited security based on attributes and shares	Limited security based on attributes and shares	C2-compatible extensive security and auditing options
File compression	Supported with extra utilities	Supported with extra utilities	Supported as part of NTFS
File activity tracking	None	None	Tracking via a log
POSIX support	None	Limited	POSIX.1 support
Hot fix	Limited	Limited	Supports hot fix
Large database support	Limited	Yes	Yes
Multiple disk drives in one volume	No	No	Yes

CHAPTER SUMMARY

❏ Network servers are used in familiar and unexpected places. They provide a foundation for the Internet, but are also used to distribute new movies to theaters, provide banking services, and help your local auto repair shop to order parts. The constantly growing use of servers has spurred the need for innovative server operating systems, such as Windows 2000 Server, which can match the demands of the millennium. The use of server-based networks is outpacing peer-to-peer networks because networking everywhere is growing more complex, so there is more need for network management.

❏ Windows 2000 Server offers traditional server capabilities such as file and printer sharing, and it offers advanced C2-compatible security, Web and network communications, and network management capabilities. One of the most important new features of Windows 2000 Server is the Active Directory. Zero Administration for Windows initiatives are also important as a way to drastically reduce the total cost of ownership of a network.

❏ The NTFS file system is a central feature of Windows 2000 because it offers strong security, fault tolerance, the ability to compress files, indexing, disk quotas, and encryption. However, Windows 2000 still retains backward compatibility with the FAT16 and FAT32 file systems. This compatibility makes it well suited for small to large server implementations on all kinds of networks.

In the next chapter, you learn about planning for the hardware used in a computer that runs Windows 2000 Server. Key issues are introduced such as CPU size, memory, disk storage, and tape storage.

KEY TERMS

Active Directory — A Windows 2000 database of computers, users, shared printers, shared folders, and other network resources, and resource groupings that is used to manage a network and enable users to quickly find a particular resource.

client — A computer that accesses resources on another computer via a network or by a direct connection.

clustering — The ability to share the computing load and resources by linking two or more discrete computer systems together to function as though they were one.

compact disc (**CD-ROM**) — A ROM medium that typically holds up to 1 GB of information.

compact disc file system (**CDFS**) — A 32-bit file system used on standard capacity CD-ROMs.

Component Object Model (**COM**) — Standards that enable a software object, such as a graphic, to be linked from one software component into another one. COM is the foundation that makes object linking and embedding (OLE) possible.

digital video disc (**DVD-ROM**) — Also called digital versatile disk, a ROM medium that can hold from 4.7 to 17 GB of information.

distributability — Dividing complex application program tasks among two or more computers.

Distributed Component Object Model (**DCOM**) — A standard built upon COM to enable object linking to take place over a network. COM is a standard that allows a software object, such as a graphic, to be linked from one software component to another (such as copying a picture from Microsoft Paint and pasting it in Microsoft Word).

fault tolerance — Techniques that employ hardware and software to provide assurance against equipment failures, computer service interruptions, and data loss.

File Allocation Table (**FAT**) **file system** — A file system based on the use of a file allocation table, a flat table that records the clusters used to store the data contained in each file stored on disk. FAT is used by several operating systems, including MS-DOS, Windows 95, Windows 98, and Windows 2000.

Hierarchical Storage Management (**HSM**) — A storage management system that enables administrators to establish storage policies, archiving techniques, and disk capacity planning through automated procedures and the coordinated use of different media, including tapes, CD-ROMs, hard drives, and Zip drives.

Hypertext Markup Language (**HTML**) — A formatting language that is used to enable documents and graphic images to be read on the World Wide Web. HTML also provides for fast links to other documents, to graphics, and to Web sites. The World Wide Web is a series of file servers with software such as Microsoft's Internet Information Services (IIS), which make HTML and other Web documents available for workstations to access.

Internet — A global network of diverse Web and information servers offering voice, video, and text data to millions of users.

intranet — A private network within an organization. It uses the same Web-based software as the Internet, but is highly restricted from public access. Intranets are currently used to enable managers to run high-level reports, to enable staff members to update human resources information, and to provide access to other forms of private data.

Kerberos — A security system developed by the Massachusetts Institute of Technology to enable two parties on an open network to communicate without interception from an intruder, by creating a unique encryption key for each communication session.

kernel — An essential set of programs and computer code that allows a computer operating system to control processor, disk, memory, and other functions central to its basic operation.

mapped folder or drive — A disk volume or folder that is shared on the network by a file server or workstation. It gives designated network workstations access to the files and data in its shared volume or folder. The workstation, via software, determines a drive letter for the shared volume, which is the workstation's map to the data.

multitasking — The capability of a computer to run two or more programs at the same time.

multithreading — Running several program processes or parts (threads) at the same time.

network — A communications system that enables computer users to share computer equipment, software, and data, voice, and video transmissions.

network operating system (**NOS**) — Software that enables computers on a network to communicate and to share resources and files.

NT File System (**NTFS**) — The native Windows 2000 file system, which has a more detailed directory structure than FAT and supports security measures not found in FAT. It also supports large disks, long filenames, and file compression.

peer–to–peer network — A network on which any computer can communicate with other networked computers on an equal or peerlike basis without going through an intermediary, such as a server or host.

Portable Operating System Interface (**POSIX**) — Standards set by the Institute of Electrical and Electronics Engineers (IEEE) for portability of applications.

privileged mode — A protected memory space allocated for the Windows 2000 kernel that cannot be directly accessed by software applications.

resource — On a Windows 2000 Server network, a server, shared printer, or shared directory that can be accessed by users. On workstations as well as servers, a resource is an IRQ, I/O address, or memory that is allocated to a computer component, such as a disk drive or communications port.

scalable — A computer operating system that can be used on small to large computers with a single Intel-based processor and on larger computers, such as those with multiple processors.

server — A single computer that provides extensive multiuser access to network resources.

server–based network — A model in which access to the network, and resources, and the management of resources, is accomplished through one or more servers.

symmetric multiprocessor (**SMP**) — A type of computer with two or more CPUs that share the processing load.

total cost of ownership (**TCO**) — The cost of installing and maintaining computers and equipment on a network, which includes hardware, software, maintenance, and support costs.

Universal Disk Format (**UDF**) — A removable-disk formatting standard used for large capacity CD-ROMs and DVD-ROMs.

virtual DOS machine — In Windows 2000, a process that emulates an MS-DOS window in which to run MS-DOS or 16-bit Windows programs in a designated area of memory.

workgroup — As used in Microsoft networks, a number of users who share drive and printer resources in an independent peer–to–peer relationship.

workstation — A computer that has its own CPU and may be used as a standalone computer for word processing, spreadsheet creation, or other software applications. It also may be used to access another computer such as a mainframe computer or file server, as long as the necessary network hardware and software are installed.

World Wide Web (**Web or WWW**) — A vast network of servers throughout the world that provide access to voice, text, video, and data files.

Zero Administration for Windows (**ZAW**) — A combination of management options and tools that enable an organization to reduce the total cost of ownership (TCO).

REVIEW QUESTIONS

1. Which file system has the ability to encrypt files?

   a. FAT32

   b. FAT16

   c. NTFS 4

   d. NTFS 5

   e. all of the above

   f. only a, c, and d

2. You have two computers that can be used as servers for the databases in a client/server application. What technique can you use to enable the load to be spread between both servers for good performance and fast access to the databases?

   a. clustering

   b. hot fixing

   c. direct linking

   d. Create a client/server algorithm that causes the first user to access one server, the second user to access the other server, the third user to access the first server, and so on for all users who log on.

3. What capability enables you to run 16-bit Windows programs in Windows 2000?

   a. Create a dual-boot system and log on to the non–Windows-2000 operating system, then log on to Windows 2000.

   b. the virtual DOS machine

   c. drive mapping

   d. none of the above because Windows 2000 cannot run 16-bit applications

4. An Active Directory element that consists of accounts, computers, and printers is a(n):

   a. container

   b. media

   c. box

   d. attribute

5. You are setting up a small network for a three-person investment firm. Each member will have a Windows 98 computer and only occasionally shares files with the other members. However, they do want you to set up a shared printer. What network model is most appropriate in this situation?

   a. server–based

   b. peer–to–peer

   c. print–based

   d. open–system

6. Which of the following operating systems can be clients of Windows 2000 Server?

   a. Windows 3.11

   b. Windows 95

   c. Windows NT Workstation 3.51

   d. Windows 98

   e. all of the above

   f. only b, c, and d

7. DVD-ROM uses which file system?

   a. NTFS 4

   b. FAT32

   c. FAT16

   d. UDF

   e. all of the above

   f. only a and b

   g. only a and d

8. You have a Pentium II 300 MHz single processor computer that is currently running Windows 2000 Server. Your server monitoring shows that you need more horsepower because the number of users has grown dramatically in just six months. Which of the following types of computers can you use to replace your existing server?

   a. a two–processor Pentium II computer

   b. a four–processor Pentium III computer

   c. an IBM ES9000 mainframe computer

   d. all of the above

   e. only a and b

   f. only b and c

9. The Social Security office in your city has accepted your bid to install Windows 2000 Server on their local network. One of the requirements of the bid is to have C2-type security. Which file system would you use on the server?

   a. NTFS 5

   b. FAT32

   c. HPFS

   d. UDF

10. When several 32-bit programs run at the same time in Windows 2000:

   a. they are limited to using only 10 percent of the CPU

   b. they each run in their own memory space

   c. they run in a special FAT-enabled partition for better performance

   d. there is a risk that if one program "crashes" it will cause the others to crash as well

11. Which of the following runs in privileged mode in Windows 2000?

   a. the kernel

   b. the command line window

   c. programs written for MS-DOS

   d. My Computer

12. Which of the following is an example of a difference between Windows 2000 Server and Windows 2000 Professional?

   a. Windows 2000 Server can use up to 4 GB of RAM, but the maximum for Windows 2000 Professional is 2 GB.

   b. Windows 2000 Professional does not support NTFS 5.

   c. Windows 2000 Server supports more user connectivity and more network services.

   d. Windows 2000 Professional can run on a single-processor computer only.

13. On which system can you use NTFS to format floppy disks?

   a. Windows NT 4.0

   b. Windows 2000

   c. Windows 98

   d. all of the above

   e. none of the above

14. You are working to set up computers and a network for a firm that processes payrolls for small and large companies. It is imperative that the computers used by each employee have an operating system that is reliable for the sensitive work performed. Which operating system would you set up on each employee's computer?

   a. Windows 98

   b. Windows 2000 Server

   c. Windows 2000 Professional

   d. Windows 2000 Server Datacenter

15. A university's finance division, which handles the administrative business end of the campus, has asked you to draft a plan to reduce the total cost of ownership for networked computers over the next two years. Which of the following would you recommend?

   a. Upgrade existing Windows NT 3.51 and Windows NT 4.0 servers to Windows 2000 servers.

   b. Upgrade Windows 3.11 and Windows 95 workstations to Windows 98.

   c. Upgrade Windows 3.11 and Windows 95 workstations to Windows 2000 Professional.

   d. all of the above

   e. only a and c

16. The ability to recover data on a hard disk after an unexpected hardware problem is called

   a. rebooting

   b. fault tolerance

   c. auditing

   d. data dumping

17. A physician's group is just implementing Windows 2000 Server on a computer that already has Windows 98, a 4 GB drive, and is formatted for FAT32. Their plan is to make this a dual-boot system for the first six months, so they have ready access to all files via Windows 2000 or Windows 98. When they install Windows 2000 Server, what file system should they use for this operating system?

   a. NTFS 5

   b. NTFS 4

   c. FAT32

   d. FAT16

18. Which of the following operating systems support power management?

   a. Windows 95

   b. Windows 98

   c. Windows NT 4.0

   d. Windows 2000

   e. all of the above

   f. only b and d

   g. only a, b, and d

19. Which of the following is true?

   a. FAT32 can be converted to NTFS 5, but NTFS 5 cannot be converted to FAT32.

   b. FAT32 can be converted to NTFS 5 and NTFS 5 can be converted to FAT32.

   c. FAT32 can be converted to FAT16, but not to NTFS 5.

   d. FAT16 can be converted to FAT32, but not to NTFS 5.

20. What is Kerberos?

   a. a form of security

   b. a type of shared drive

   c. a Web server

   d. a form of multithreading

21. Long filenames can consist of up to how many characters?

    a. 8

    b. 11

    c. 128

    d. 256

22. The alumni office at your school is planning to implement a server that will hold a 40 GB database. Which of the following file systems can handle a single database file of this size?

    a. NTFS 5

    b. NTFS 4

    c. FAT32

    d. all of the above

    e. only a and b

23. Which of the following languages is (are) supported by Windows 2000?

    a. Hindi

    b. Chinese

    c. English

    d. all of the above

    e. only b and c

24. The ability to install a variety of drivers for modems, monitors, keyboards, disk adapters, and pointing devices in Windows 2000 is an example of:

    a. testability

    b. extensibility

    c. distributability

    d. resource sharing

25. Which of the following is new to Windows 2000 Server?

    a. Active Directory

    b. Web-based Enterprise Management (WBEM)

    c. NTFS security

    d. all of the above

    e. only a and b

    f. only a and c

HANDS-ON PROJECTS

Project 1-1

In this hands-on activity you try out My Computer in Windows 2000. You will need access to a computer running Windows 2000 Server or Windows 2000 Professional, and an account provided by your instructor.

To use My Computer:

1. Log on to Windows 2000 by pressing **Ctrl+Alt+Del**.
2. Enter the user name and password in the Log on to Windows dialog box and then click **OK** (you may also need to enter the domain name).
3. Double-click **My Computer** on the desktop to open the My Computer window. Click a drive such as C: to view how the display changes (see Figure 1-6)
4. Maximize the window by clicking the maximize button on the right side of the title bar.
5. Click the **View** menu, highlight **Toolbars**, and notice the toolbar options. Make sure that a checkmark appears in front of **Standard Buttons** and **Address Bar**. If one of these options is not checked, click it now. If you need to check the other option, click the **View** menu, point to **Toolbars**, and click **Address Bar** and/or **Standard Buttons**.
6. Click the **View** menu one more time, highlight **Explorer Bar**, and notice the options. Click **Search** and observe the search panel that is displayed in the left side of the window. This tool enables you to search for a specific file or folder in Windows 2000.
7. Move the cursor to point to a disk drive. What information is displayed about the drive? Record your observations in a lab journal or in a word processed document.
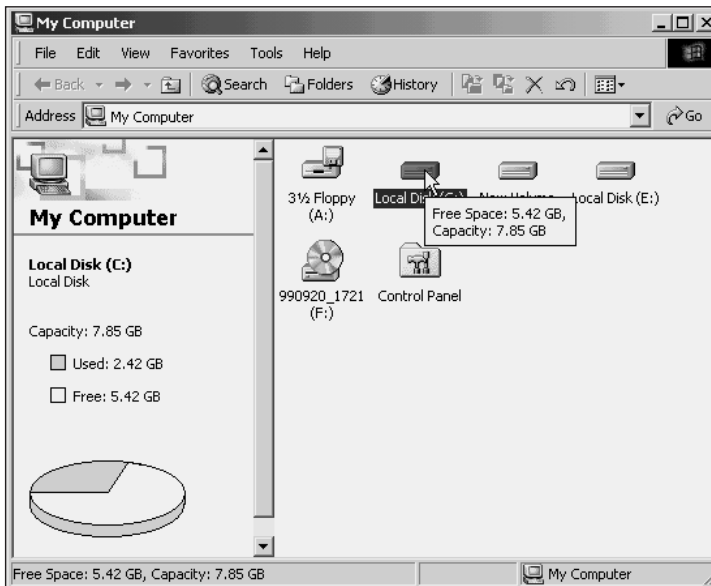8. Click the **Close** button on the right side of the title bar to close My Computer.

Figure 1-6   My Computer

Project 1-2

In this hands-on activity, you briefly experiment with the Start button to practice starting a program in Windows 2000.

To start a program:

1. Log on to Windows 2000, if you logged off after Hands-on Project 1-1.
2. Click the **Start** button on the desktop.
3. Highlight **Programs** and then highlight **Accessories**. (If Accessories and other menus are not displayed, click the double up or down arrows to view the Program menu's contents.)
4. Notice the accessory options that are installed in Windows 2000. Move the cursor to each option to display its menu contents or a brief explanation of its function. Record the options in your lab journal or in a word-processed document.
5. Click **WordPad** or **Calculator** to practice starting an application.
6. How would you open Windows Explorer?
7. Close the application that you opened in Step 5, when you are finished viewing it.

Project 1-3

This hands-on activity enables you to view workstations connected to the network through the My Network Places icon on the Windows 2000 desktop. You will need access to a computer running Windows 2000 Server or Windows 2000 Professional, and an account provided by your instructor.

To view the networked workstations:

1. Log on to Windows 2000.
2. Double-click **My Network Places** on the desktop (see Figure 1-7).
3. Click the **View** menu, highlight **Toolbars**, and click **Standard Buttons** (do not click it if it is already checked).
4. Double-click **Entire Network** and click the hyperlink to **Search for computers** (see Figure 1-8).
5. Click the **Search Now** button to look for all computers.
6. Notice how many computers are connected to the network and record four or five names in your lab journal or in a word-processed document. Are any printers listed?
7. Double-click one of the computers to determine if it has resources to share. If it does not, click the Back arrow on the button bar and try another computer. When you find a computer that is sharing resources, notice if the resources are folders, printers, or both.
8. Close the screen showing shared resources and close the entire Network screen.
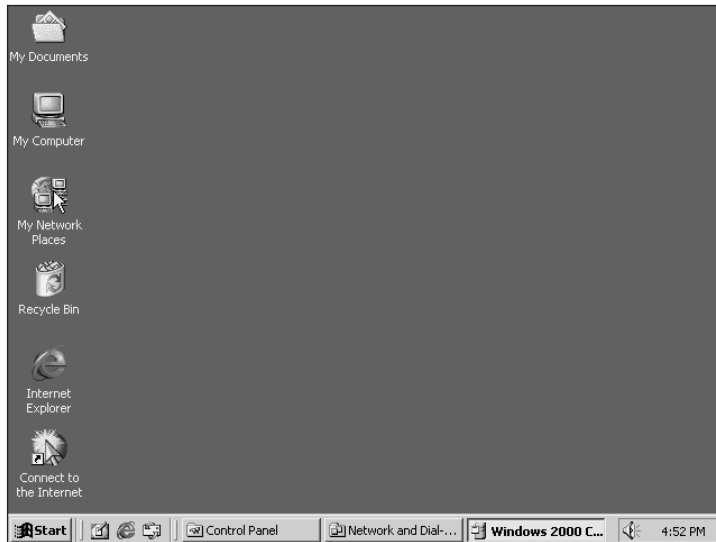
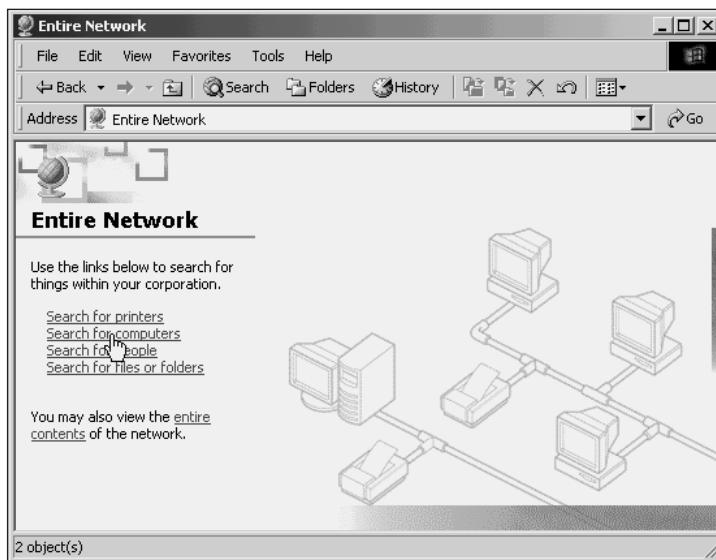**Figure 1-7** Selecting My Network Places

Figure 1-8 Searching for network computers

Project 1-4

In this hands-on activity, you determine the operating systems used by four computers on your network.

To determine the operating systems in use:

1. Log on to Windows 2000.
2. Double-click **My Network Places** on the desktop.
3. Double-click **Entire Network**.
4. Click the **entire contents** hyperlink on the left side of the screen.
5. Double-click **Microsoft Windows Network**.
6. Double-click a domain (one of the icon(s) representing connected computers), such as **TheFirm**.
7. Right-click a computer and click **Properties**.
8. Notice the name of the domain or workgroup to which the computer belongs, as shown in the Comment section of the Properties dialog box.
9. Notice the operating system type, as shown in the Type section, and then close the dialog box.
10. Repeat Steps 7, 8, and 9 three more times on different computers and record the information that you obtain in your lab journal or in a word-processed document.
11. Close My Network Places or the domain screen when you are finished.

Project 1-5

My Network Places has many new options that are not available in its predecessor, Network Neighborhood. For example, it enables you to verify your network connection and the speed of the network. This activity shows you how to do both.

To verify the network connection and network speed:

1. Log on to Windows 2000.
2. Double-click **My Network Places** on the desktop.
3. In the My Network Places information text on the left side of the window, click the underlined hyperlink that says **Network and Dial-up Connections**.
4. Double-click **Local Area Connection**.
5. In the connection section of the Local Area Connection Status dialog box, determine the status and the speed of the connection (see Figure 1-9).
6. Determine how long you have been connected and the number of packets sent and received.
7. Record the information you have gathered in your lab journal or in a word-processed document.
8. Click Close on the Local Area Connection Status dialog box and close the Network and Dial-up Connections window.
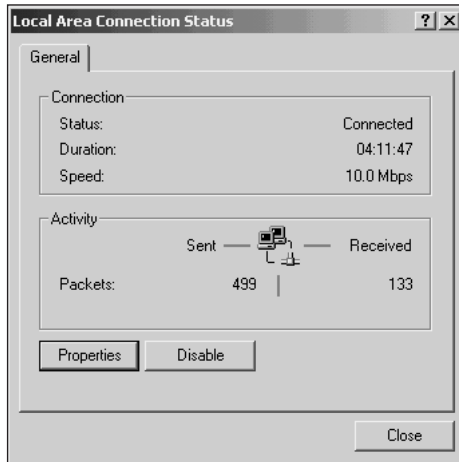
Figure 1-9 Network connection status

Project 1-6

In this project, you open the Microsoft Management Console (MMC) and view the available snap-ins for Windows 2000 Server. Before you start, find out from your instructor what account to use so that you have privileges to access the MMC.

To access the MMC:

1. Log on to Windows 2000 Server.

2. Click **Start**, click **Run**, and enter **mmc** in the Run box. Click **OK**. Maximize the console screens, if necesary.

3. Click the **Console** menu.

4. Click **Add/Remove Snap-in** or press **Ctrl+M**.

5. Notice which snap-ins are already set up in the MMC.

6. Click the **Add button** in the Add/Remove Snap-in dialog box.

7. Scroll through the options in the Add Standalone Snap-in dialog box. How would you add a snap-in to the console?

8. Do you find any snap-ins that are from a vendor other than Microsoft? If so, what are they?

9. Record your observations about the snap-ins and vendors in your lab journal or in a word-processed document.

10. Click **Close** in the Add Standalone Snap-in dialog box, click **Cancel** in the Add/Remove Snap-in dialog box, and close the MMC. (Click **Cancel** if you are asked to save console settings.)

Project 1-7

In this project, you view the virtual DOS machine process in action. Before you start, find out the location of a 16-bit application from your instructor.

To view the virtual DOS machine process:

1. Log on to Windows 2000 Server.

2. Click **Start** and click **Run**.

3. Enter the path and name of the 16-bit application and click **OK**, or use the Browse button to find it. If you use the Browse button, find the appropriate drive in the Look in box and then click through the appropriate folders and subfolders. Double-click the application in the Browse window, and then click **OK**.

4. Press **Ctl+Alt+Del** (don't worry, you won't reboot the computer).

5. Click **Task Manager**.

6. Once the Task Manager starts, click the **Processes** tab (if it is not displayed already).

7. Use the scroll bar to locate ntvdm.exe.

8. Notice the name of your 16-bit process listed under the ntvdm.exe process.

9. What other process(es) is (are) running under ntvdm.exe? Record your observations in your lab journal or in a word-processed document. Close Task Manager and then close the 16-bit application.

Project 1-8

In this project, you practice compressing all files in an NTFS 5 folder. Before you start, ask your instructor about which folder to use for this project.

To compress the files in the folder:

1. Log on to Windows 2000 Server.

2. Click **Start**, point to **Programs**, point to **Accessories**, and then click **Windows Explorer**.

3. Scroll or browse to find the folder that your instructor has designated for this assignment and right-click it.

4. Click **Properties**.

5. Click the **Advanced** button.

6. Click the check box, **Compress contents to save disk space**. Click **OK**.

7. Click **OK**.

8. Close Windows Explorer.

Project 1-9

In this hands-on activity, you use Windows 2000 Explorer to view files and then to view the properties of a folder created in NTFS. Make sure that you log on to a computer running Windows 2000 Server or Windows 2000 Professional that is using the NTFS.

To use Explorer:

1. Click the **Start** button, point to **Programs**, point to **Accessories**, and then click **Windows Explorer**.

2. Notice there are two scroll panels or panes of information, one containing Folders on the left, and one that is untitled on the right.

3. Scroll down to view folders and files in both panels, or click My Computer in the left panel and double-click the drive containing Windows 2000 system files in the right panel, such as drive C.

4. Scroll to the WINNT folder. If the folder is not displayed, look for it on drive D (or another drive) in the desktop under the Folders pane. Every folder created in NTFS contains properties, such as information about the folder size, sharing, and security options. Right-click the **WINNT** folder and then click the **Properties** option on the shortcut menu.

5. Click each tab to view its contents and make notes about its purpose in your lab journal or in a word-processed document.

6. If you have access to Windows 95 or Windows 98, compare the tabs and properties of a Windows 2000 NTFS folder with a FAT16 or FAT32 folder in Windows 95 or Windows 98. Record your comparisons.

7. Click **Cancel** to close the Properties dialog box.

8. Close Windows Explorer.

Project 1-10

In this hands-on activity, you use My Network Places to find out how to map a network drive. Before you start, ask your instructor for the name of a network computer that is set up to share a folder.

To use My Network Places to map a drive:

1. Double-click **My Network Places** on the desktop.

2. Double-click **Entire Network** and then click the hyperlink to **Search for computers**.

3. Click the **Search Now** button to look for all computers.

4. Double-click the computer specified by your instructor or continue to double-click computers until you find one with a shared folder.

5. Right-click the shared folder and then click **Map Network Drive**.

6. Select a drive letter for the mapped drive or use the default drive letter (see Figure 1-10).

7. Click **Finish** to map the drive.

8. In the resulting drive or domain window, examine the files and subfolders that you can access, and double-click a text file to view its contents, if one is available.

9. Close the drive window and the other windows you have opened.

10. How would you access the drive you mapped in Windows Explorer or My Computer? Record your answer in your lab journal or in a word-proccessed document.
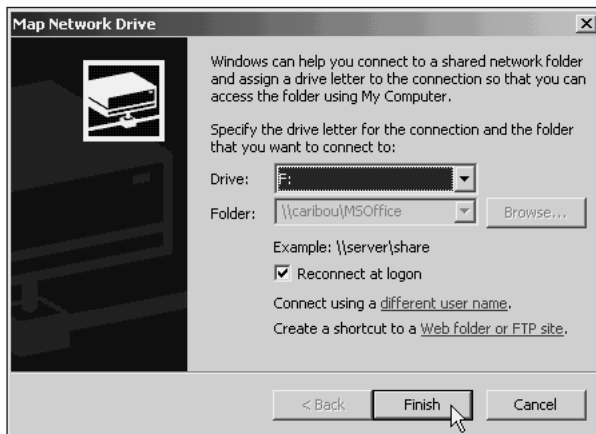
Figure 1-10   Mapping a network drive

CASE PROJECT

Aspen Consulting Project: Planning a Server Implementation

In this and the chapters that follow, you will work on an extensive range of projects as a Windows 2000 Server consultant for Aspen Consulting, a computer consulting firm that operates from offices on the East and West Coasts in the United States and from Vancouver and Montreal in Canada. Your boss is Mark Arnez, one of the managing partners of Aspen Consulting. Aspen Consulting has over 100 consultants who specialize in networking, server operating systems implementation, and support of Microsoft computer operating systems. Your company has clients throughout the United States and Canada. The work is challenging because your clients are very diverse, including accounting firms, manufacturing companies, colleges, universities, law firms, mail-order houses, and publishing companies.

Today Mark asks you to plan a server installation for a small hospital in a rural area near Vancouver. The hospital has 32 computers running Windows 95 and Windows 98 that are just now being networked. They also have an old IBM System 38 minicomputer that has handled patient records and accounting. The company that supports their patient records and accounting systems has gone out of business, and the hospital is considering two new software systems that run on Windows 98, Windows NT, and Windows 2000. They also want to develop a software system that enables doctors, patients, and members of the community to look up health information from a 500 MB database that the hospital has just purchased, but not yet implemented.

1. What networking model do you recommend for this hospital and why?

2. The hospital administrator does not fully understand what a server can do. Explain the features that servers offer.

3. Prior to hearing your answer in question 2, the hospital administrator was thinking about using Windows 98, Windows 2000 Professional, or Windows 2000 Server to replace the IBM System 38. Now she asks how your response about servers might be clarified through a comparison of what these operating systems can provide. Prepare a table or a report that compares these operating systems to one another in a network setting.

4. Next she asks that you make a recommendation for the 500 MB database they have purchased. Should this be put on a full-featured server or made available as a shared drive from a Windows 98 computer? Fully explain your answer.

5. Because patient records and patient/doctor information must be kept confidential, which file system would you recommend for the computer that houses the patient records and accounting systems? Why do you recommend this file system and what other advantages does it offer in the context of information sharing for the hospital?

6. As a rural hospital, they have to be conscious of the budget as they move into the future. What are some factors that they can consider in this implementation to help reduce computer and networking costs over the next few years?

7. Last, as she is considering server and workstation options, the administrator remembers that they use an old 16-bit Windows purchase-order system. Can this run in Windows 2000?

OPTIONAL CASE PROJECTS FOR TEAMS

Team Case One

Your boss, Mark Arnez, wants to compile a list of ways in which Windows 2000 Server is used in small, medium-sized, and large organizations. He asks you to form a small group of consultants to compile the most comprehensive list possible. Use the library, the Internet, and any other resources to compile a list, and report back to Mark.

Team Case Two

You are in the lunchroom discussing an assignment with two of your colleagues. You are working with a small tax preparation firm that consists of five people—four tax accountants and one administrative assistant. Their office is networked, and they each have computers running Windows 95. The administrative assistant's computer is used as a server in that it stores the tax-accounting software and each client's records in a database—all made available through a shared drive. Unfortunately, there are times when all four accountants access the shared drive simultaneously, resulting in delays when they need to quickly access information because they have clients in their offices. Your debate is whether to upgrade all computers to Windows 98 or to install a server, even though this is just a small office. Poll your colleagues and create a report summarizing your group's conclusions.